

ЭЛЕКТРОННЫЕ ИНФОРМАЦИОННЫЕ ТЕХНОЛОГИИ В НАУЧНЫХ И ПРИКЛАДНЫХ РАЗРАБОТКАХ

УДК 519.673

THE MATHEMATICS OF SUDOKU

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Sudoku is a puzzle presented on a square grid that is usually 9×9 , but is sometimes 16×16 or other sizes. Here will be considered only the 9×9 case, although almost everything that is said can easily be extended to the puzzles with different dimensions. Sudoku puzzles can be found in many daily newspapers, and there are thousands of references to it on the internet.

The main purpose of an investigation is to write a program that generates sudoku with a single solution. And the first thing to start is to understand the mathematical approaches to solving sudoku. So in this article it will be considered the mathematics of sudoku.

Why sudoku is important? The curiosity sparked by the popularity of the puzzle has rendered sudoku problems relevant. Mathematician and computer scientists are pondering many questions centered on sudoku including the questions regarding how to solve the puzzle. Practical application is yet to be determined but people who have high aptitude for sudoku have earned large sums of money by participating in competitions. Popular game websites have standard sudoku as well as various variations to the game for sale on their site. This illustrates the business side of sudoku. In order for these games to be created, mathematicians, programmers, software engineers and so on must dive deep into some of the questions that we are considering in this paper. They must know how many sudoku puzzles they want to include in their game software which requires the knowledge of the number of unique puzzles that there are. They must also be aware of algorithms that solve the puzzle fairly quickly without utilizing excessive processing power (otherwise, their game will slow computers down and may not be accepted by sudoku enthusiasts). These questions are more are some of the reasons why sudoku research is important. Beyond the mathematical questions raised by sudoku and the possibility earning money from the puzzles, some believe that the concepts used by both the human solver and the computer are analogous to the concepts used in scientific research. Dr. Mano Singham, one of the proponents of this idea points out the similarities between scientific research processes and Sudoku when he said, "normal scientific research within a paradigm is largely a puzzle solving exercise in which there is an assurance that a solution exists to the problem and that it is only the ingenuity of the scientist that stands between her and a solution. The sudoku problem is like that. We know that a solution of a particular form exists and it is this belief that makes people persevere until they arrive at a solution." [1]. Sudoku is also being mentioned by health professionals as a tool for mental fitness. Like other puzzles, sudoku has been known to prevent and even reverse mental health defects such as Alzheimer's disease and other forms of dementia.

The original grid has some of the squares filled with the digits from 1 to 9 and the goal is to complete the grid so that every row, column and 3×3 sub-grid (of which there are 9) contains each of the digits exactly once. Some initial configurations admit zero solutions and others admit multiple solutions, but these are usually considered to be invalid puzzles.

In figure 1 a (relatively easy) puzzle appears on the left. If you've never tried to solve a sudoku puzzle, it would be very informative to try to solve this one now, and see what strategies you can come up with before you read the rest of this article. It will probably take more time than you think, and you will get much better with practice.

	1	2	3	4	5	6	7	8	9
a			4	8					
b		9		4	6			7	
c		5					6	1	4
d	2	1		6			5		
e	5	8		7		9		4	1
f			7			8		6	9
g	3	4	5						
h		6			3	7		2	
i						4	1		

Figure 1

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Let us start with discussion of various solution techniques and any related mathematics along with the technique.

There is a large literature on sudoku on the internet, and as far as possible, we will try to use the same terminology in this article as that which is commonly used on the internet.

- A "square" refers to one of the 81 boxes in the sudoku grid, each of which is to be filled eventually with a digit from 1 to 9.

- A "block" refers to a 3×3 sub-block of the main puzzle in which all of the numbers must appear exactly once in a solution. We will refer to a block by its columns and rows. Thus block *ghi456* includes the squares *g4*, *g5*, *g6*, *h4*, *h5*, *h6*, *i4*, *i5* and *i6*.

- A "candidate" is a number that could possibly go into a square in the grid. Many methods we will examine will eliminate candidates one after the other until there is a unique number that can go in a square.

- Sometimes an argument will apply equally well to a row, column or block, and to keep from having to write “row, column or block” over and over, we may refer to it as a “virtual line”. A typical use of “virtual line” might be this: “If you know the values of 8 of the 9 entries in a virtual line, you can always deduce the value of the missing one.” In the 9 × 9 sudoku puzzles there are 27 such virtual lines.

- Sometimes you would like to talk about all of the squares that cannot contain the same number as a given square since they are in the same row, column, or block. These are sometimes called the “buddies” of that square. For example, you might say something like, “If two buddies of a square have only two possible candidates, then you can eliminate those as candidates for the square.”

Resources:

1. Mano Singham, Sudoku and Scientific Research, http://blog.case.edu/singham/2006/02/01/sudoku_and_scientific_research February 1, 2008 Accessed November 2, 2019
2. Херон Э., Джеймс Э. Судoku для "чайников": Пер. с англ. – К.: Вильямс, 2007 – 336 с.
23 Рейнгольд Э., Нивельгерт Ю., Део Н. Комбинаторные алгоритмы. – 1980

УДК 681.3

**ОПЫТ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ САЙТОВ
С УЧЕТОМ ОСОБЕННОСТЕЙ ИХ ПРИМЕНЕНИЯ****Абрамук А. И.**

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Базовые характеристики сайтов и требования к ним наряду с качеством внутреннего содержания определяют также свойство юзабилити (usability), означающее в узком смысле удобство использования сайта, эргономичность интерфейса (простоту, интуитивность, доступность, удобство навигации и т. п.), а в расширенном понимании – степень эффективности его работы. При этом если сайт разработан для получения прибыли, то характеристики посещаемости и конверсии становятся жизненно необходимыми.

Здесь рассмотрен опыт улучшения эффективности такого рода сайтов на примере интернет-витрин, -магазинов, обеспечивающих типовой набор функций по ведению и оперативной корректировке контента – информации о товарах, заказах, а также обеспечению удобного доступа и пользовательских функций по выбору и заказу товаров и т. п.

Одним из важных направлений в доработках этих сайтов является поисковая оптимизация, которая позволяет делать их более “полезными” с точки зрения поисковых систем и “видимыми” для пользователей. Здесь наряду с внутренним улучшением проводилась внешняя оптимизация, направленная на рост узнаваемости сайта, наращивание внешней ссылочной массы – улучшение ссылочного профиля сайта.

Основные этапы мероприятий:

1. Начальная оптимизация на основе анализа общей видимости сайта с учетом характеристик сайтов-конкурентов, их организации и ссылочного профиля. Оценка частот-